PILOT'S HANDBOOK

MODEL PBY-5 FLYING BOAT

U. S. NAVY
CONTRACT 70496

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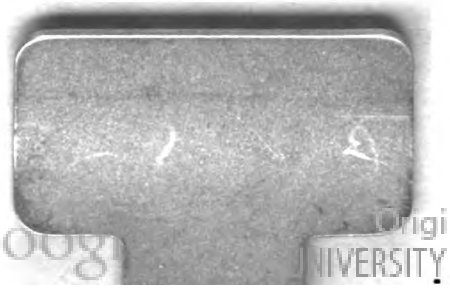

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PILOT'S HANDBOOK
U.S. NAVY
PBY-5 AIRPLANE

RELEASED BY THE U.S. BUREAU
OF AERONAUTICS
NAVY DEPARTMENT

DECEMBER 2, 1940
CONSOLIDATED AIRCRAFT CORPORATION
SAN DIEGO, CALIFORNIA

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PRELIMINARY

PILOT'S HANDBOOK FOR THE

PBY-5 PATROL BOMBER AIRPLANE

SECTION I

FOREWORD

A. Purpose

The purpose of this book is to describe briefly the principal operating features of the PBY-5 airplanes with which the flight personnel are concerned. As in many of the advanced type large airplanes, the duties of operating the PBY-5 are divided between the pilot and the flight engineer. With this division of duties, it becomes essential for the pilot and flight engineer to co-ordinate their respective duties at all times for the safe and economical operation of the craft.

The limitations of performance and the operation of the plane must be fully understood by the entire crew as well as the pilot and engineer.

B. Scope

This book is brief, but covers all the features of the plane necessary for its efficient operation. Details of the equipment and mechanisms of the airplane are covered by other manuals placed aboard the airplane or at the operations base. Specific reference shouldbe made to the Erection and Maintenance Manual as well as to the other manuals and handbooks for airplane equipment.

SECTION II

GENERAL DESCRIPTION OF OPERATION

A. Description of Airplane

The PBY-5 is a twin engined semi-cantilever high wing monoplane flying boat with retractable wing tip floats. It is of all metal construction except for the movable control surfaces and trailing edge. These surfaces consisting of the ailerons, rudder, and elevators and trailing edge are of metal construction with a fabric covering.

B. Hull

The hull is divided into five main watertight compartments separated by four main bulkheads equipped with watertight doors. The pilot's compartment is immediately forward of the first watertight bulkhead. The radio operator's compartment is aft of the pilot's compartment on the starboard side. The navigator is stationed at the port side of the same compartment. The engineer's station is immediately aft of the second watertight bulkhead in the superstructure which supports the wing on the hull. The living quarters of the crew are aft of the engineer's station.

C. Signal System

Two systems of communication are provided for the pilot and engineer due to their division of operation of the controls. These two systems are the Visual Signal and Type RL-24-A Interphone.

The visual signal system consists of panels of switches and marked lights with identical positional arrangement for the pilot and the engineer. The system for the pilot is on the control yoke (Figure 1), and the one for the engineer is on his instrument panel, (Figure 5). The visually indicated operations as shown in the Visual Signal System of Figure 5 and listed from left to right are as follows: "Raise Floats", "Lower Floats", "Full Rich", "Auto. Rich", "Auto. Lean", "Stop Engines", "Recall", "Interphone", "Secure".

The Visual System is operated by three-way control switches. Either switch controls lock light "ON" or "OFF". The pilot may signal the engineer to perform certain operations by turning a light on. The engineer may signal "done" by turning light off.

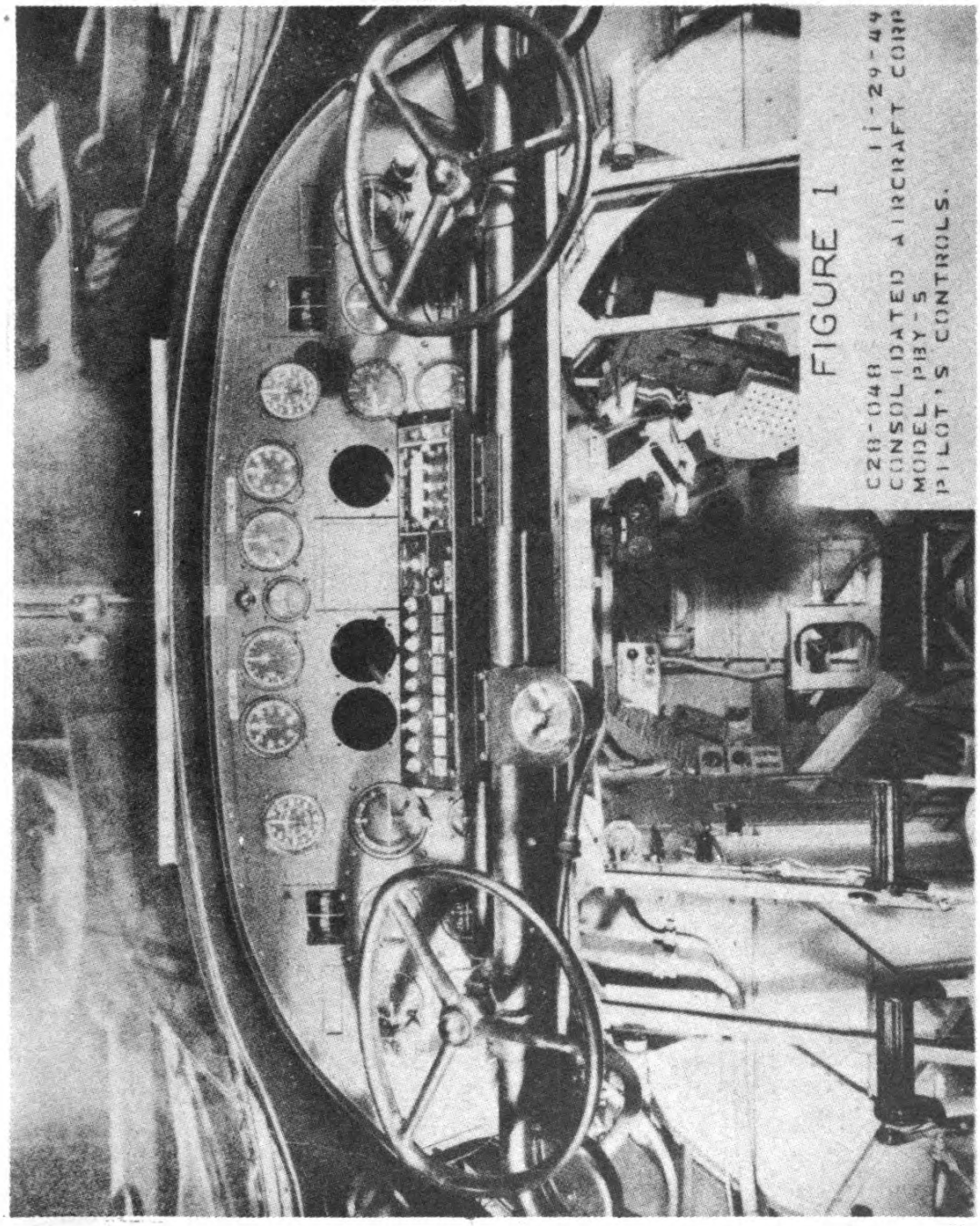


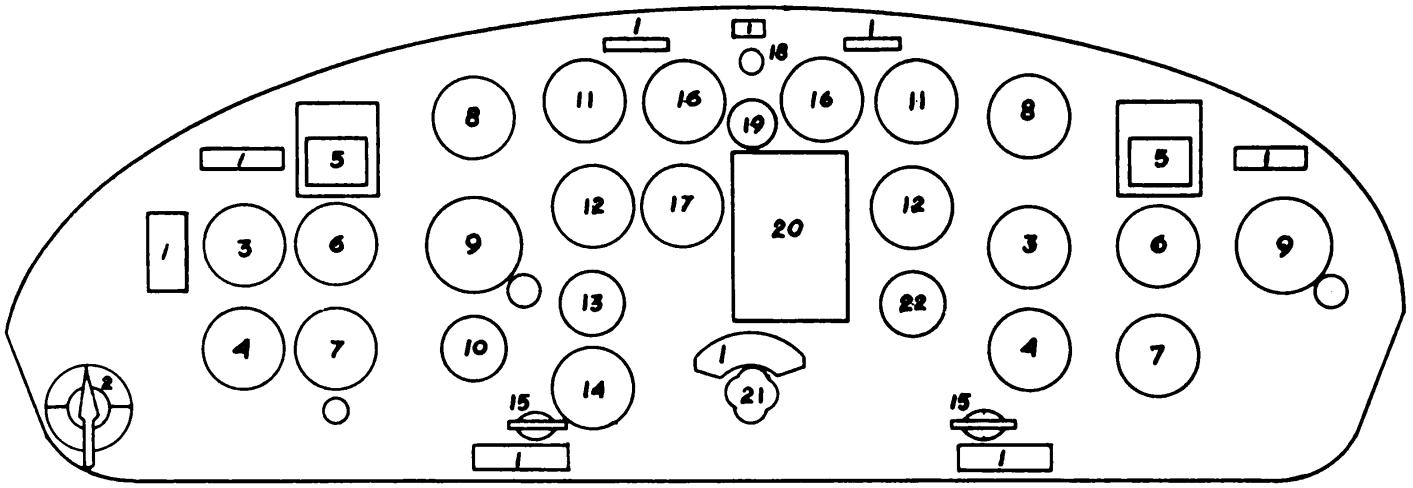
FIGURE 1

C28-048 11-29-44
CONSOLIDATED AIRCRAFT CORP.
MODEL PBY-5
PILOT'S CONTROLS.

By means of the signal switch marked "Interphone" the pilot or engineer may indicate to the other that he desires to communicate by means of the interphone system. This system consists of individual equipment for each of the pilots, flight engineer, bomber, the two waist gunners, tunnel gunner, navigator and radio operator. The equipment consists of a plug-in box, head set and microphone. The plug-in box for the pilots is located outboard of the seats; that for the radio operator, on the interphone control unit; that for the engineer, on the starboard side of the engineer's station. All plug-in boxes are clearly marked. There is a control box at the radio station and one at the pilot's station, on the bulkhead aft of the seats (See Figure 3) where it is accessible to both pilots.

In the operation of the interphone system, the pilots, individually or together, connect their phones and microphones to the inter-squadron sets and interphone communication system (ICS). There are four possible combinations marked on the switch box plate. In all positions of the control switch at least on pilot has one phone and his microphone on the interphone system and is therefore able to communicate by voice with the engineer. It is recommended that the pilot's control box switch be left in position 4 for take-offs and landing. To obtain this position, stop at #3, the most used position; pull out the handle to release the stop, then pull the lever down for the 4th position. This connects both pilots to the interphone position without interference from the inter-squadron set. If the radio operator has cut himself off from the ICS, he may be recalled by using the Visual Recall switch on the control box.

The radio operator has one control box with four controls on it. These are the selector switch which is used to select the phone combination that the radio operator desires; the ICS on and off switch; the main power supply switch; the Visual Recall switch. The main power supply switch and the individual power supply switches for both the Visual and Interphone communication are controlled by the radio operator. These switches MUST BE TURNED "ON" AND LEFT ON WHEN PILOT IS IN COMMAND OF THE SHIP. By turning the Inter-Communication System switch "OFF", the radio operator can cut out the Inter-Communication System. He can be called by the pilots with the Visual Recall switch.



1. NAMEPLATE
2. VACUUM PUMP SELECTOR VALVE
3. RATE OF CLIMB INDICATOR
4. ALTIMETER
5. COMPASS, MK-IX
6. TURN AND BANK INDICATOR
7. DIRECTIONAL GYRO, MK I-A
8. AIR SPEED INDICATOR
9. GYRO HORIZON, MK. II
10. SUCTION GAGE
11. MANIFOLD PRESSURE GAGE
12. PILOT DIRECTOR
13. DE-ICER PRESSURE GAGE
14. ANTI-ICER CONTROL
15. MANUAL BOMB AND TORPEDO RELEASE
16. ELECTRIC TACHOMETER, MK-V
17. CLOCK
18. FLOAT WARNING LIGHT
19. SYNCHRONIZING INDICATOR, MK-V
20. CHECK OFF LIST CARD
21. AILERON TAB CONTROL
22. A.F.C.E. TELL TALE LIGHT

FIG. 2

PILOTS' INSTRUMENT PANEL

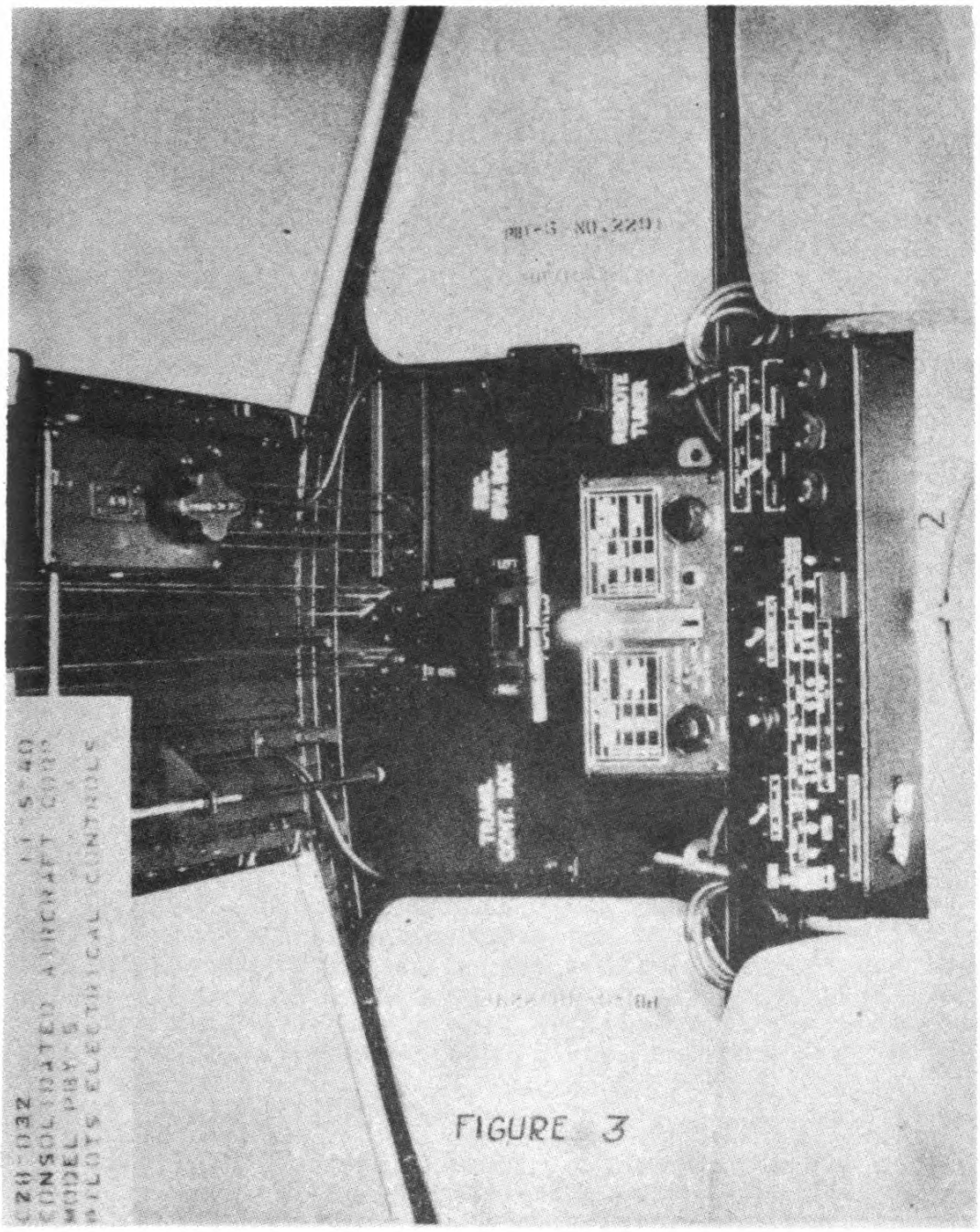


FIGURE 3

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SECTION III

COMPARTMENT ARRANGEMENT AND CONTROLS

A. The surface controls consist of the ailerons, elevators and rudders. The arrangement is the conventional dual control, side-by-side type, with the pilot on the left and the co-pilot on the right, separated by a central catwalk which extends throughout the useable length of the hull. Figure 1 of this Handbook illustrates this general arrangement. The dual controls are the wheel, yoke and pedal type, with conventional operation. The rudder pedals are adjustable fore and aft by a lever on the outboard side of each pedal, operable by kicking the pedal with the foot. The seats are adjustable for the pilots, as shown on Figure 4.

Trim tabs are provided on rudders, elevators, and the port aileron. The aileron tab is controlled by a knob located in the center of the pilots' instrument panel, Figure 2. The rudder and elevator tab controls are located overhead between the pilots, Figure 4. For take-off, the rudder tab should be set 2° to the right, the elevator tab 3° nose up, and the aileron tab should be in the neutral position.

The rudder controls may be locked in neutral by pulling the hinged locking lever, on the wall beside the pilot, out. This throws a locking pin in the empennage actuating mechanism. A bar stowed in the airplane, locks the elevators and ailerons when it is strapped to the control wheel and fastened to the bulkhead over the pilot's seat.

Pilots' Power Plant Controls

The pilots' power plant controls consist of: the throttle which is located above the pilots, Figure 4; engine ignition switches on the control yoke between the pilots, Figure 1; master switches on the yoke, with the ignition switches; and propeller pitch controls which are located overhead between the pilots, as shown on Figure 4

Pilots' Auxiliary Controls

The pilots' auxiliary controls include the rudder pedal adjustment on the outboard edge of each pedal. To release for setting, the adjustment lever is to be kicked out of position. When released, it will engage in the nearest hole. Seat adjustments can be made by use of levers on the outboard sides of the pilot's and co-pilot's seats, as shown on Figure 4. There is a seat release for a fore and aft adjustment, and a release for a tilting adjustment.

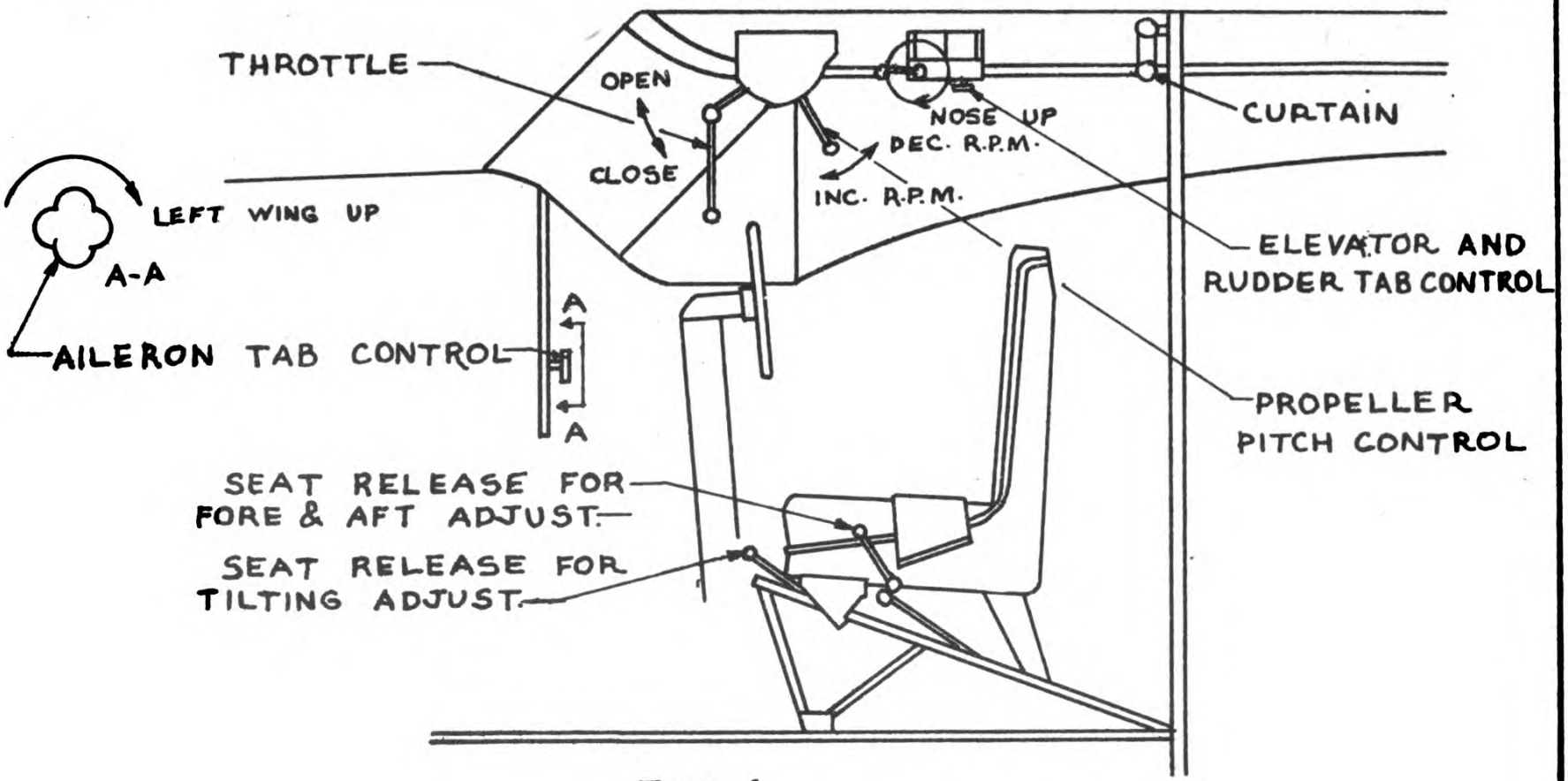

FIG. 4.

PILOTS' AUXILIARY CONTROLS

The Visual Signal system described in Section II is on the yoke between the pilots and is connected up with a similar box on the engineer's panel.

The electrical switches on the instrument board consist of a synchronizing indicator, and anti-icer control switch as shown on Figure 2.

The pilots' interphone control box is on the bulkhead aft of the pilots. The switches on the electric panel are as follows: master electrical system batteries, generators, battery and generator ammeter, voltmeter, light, de-icers, and main power. Care should be exercised to see that these main power switches are "ON" when necessary to furnish power to other switches needed in the operation of the airplane.

The controls for the retractable wing tip floats are in the flight engineer's compartment. The pilot must signal the engineer to have them raised or lowered. There are warning lights on both the pilot's and engineer's instrument panels which light when throttles are partly closed and floats are "UP".

Pilots' Useful Load Controls

The manual bomb or torpedo salvo release is located on the pilot's instrument panel (Figure 2). Electrical bomb release is accomplished by closing the bomb release switch and depressing the firing key in the starboard end of the pilot's electrical switch panel. Torpedoes shall be released by moving the torpedo release switch to "Torpedo Release" and depressing the firing key on the electrical panel.

For detailed operation of the bomb and torpedo releases, refer to Part C, Section V of the Erection and Maintenance Manual.

The flare release handles are located above the interphone control box aft of the pilots. Pull the port handle to release a port flare and the starboard handle to release a starboard flare.

B. Flight Engineer's Compartment Power Plant Controls and Instruments (Figure 5).

The manifold pressure gages are the same type as the pilots' gages. The gages read the pressure of the mixture entering the engine cylinders. They will respond to the throttle and the propeller governor setting.

Each cylinder temperature gage indicates the cylinder head temperatures of a single cylinder on its respective engine.

The oil quantity gage is of the electric liquidometer type. It indicates the amount of oil remaining in the tanks. By use of the selector switch, it will give a reading for either the port or starboard tank.

The fuel tank dump valve controls are located directly over the engineer's head. The lever should be pulled to release the fuel. The dump valves will close when the handle is released, allowing a selected quantity of fuel to be dumped.

At the time of publication of this handbook, FUEL DUMPING from all Model PBY airplanes is PROHIBITED by Service and Bureau orders, because of dangerous flow of fuel and vapor into wings and hull while fuel is being released. Improvements to the fuel dumping system are under test. See current Service and Bureau orders regarding fuel dumping.

The cowl flap controls are below the instrument panel on bulkhead 4.0. The flaps for each engine are opened or closed by means of the cranks operated according to the instruction plate on the bulkhead.

The Carburetor Air Control knobs are on the engineer's instrument panel. Their use is described in Part IV-F.

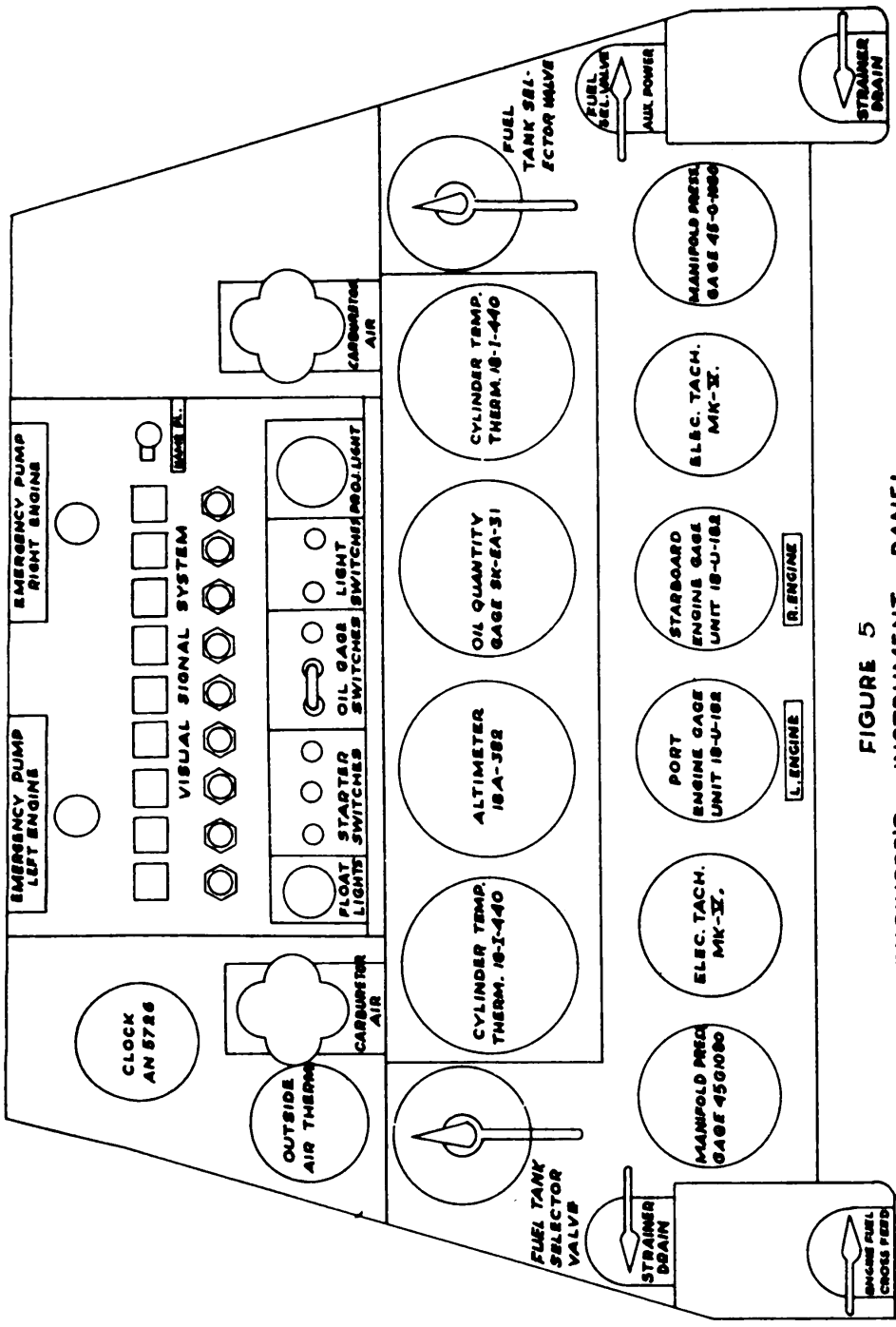

FIGURE 5
ENGINEER'S INSTRUMENT PANEL

REFER TO C.A.C. DWG. 28F8005

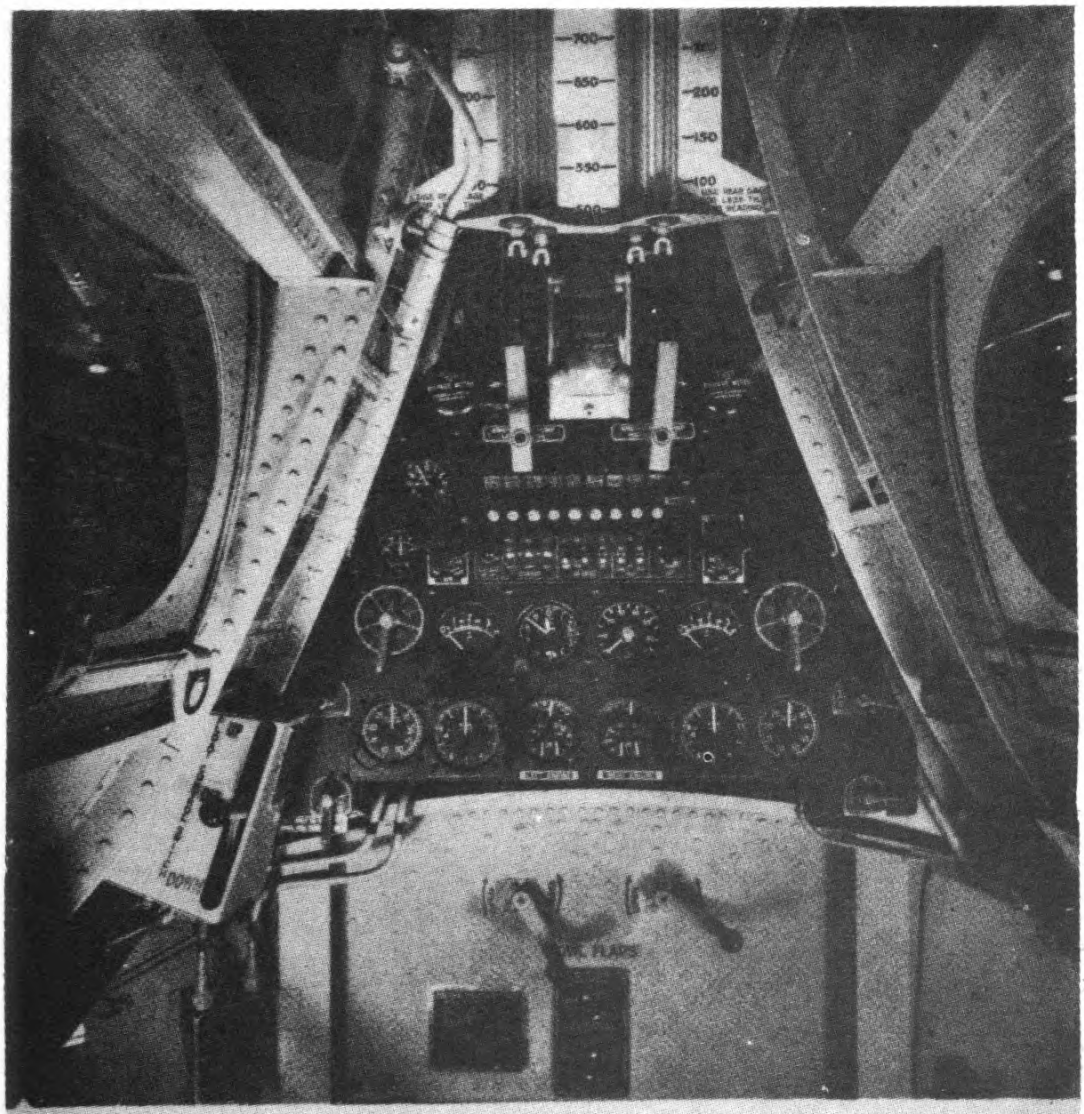

FIGURE 6

C28-035 11-5-40
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MODEL PBY-5
FLIGHT ENGINEER'S COMPARTMENT.

Carburetor Air Control knobs are on the instrument panel over the nameplates as shown on Figure 5. These control the valve in the air intake duct.

In normal operations, the control is in the full "DIRECT" position since the carburetor is a "non-icing" type. In this position, air enters the carburetor scoop directly from the rammed air intake. When the control is moved to the "ALTERNATE" position, carburetor air is taken from a protected opening in the scoop within the engine nacelle.

The mixture control is just above the instrument panel. The handle positions are marked on the quadrant.

The fuel flowmeters are above the instrument panel on the forward bulkhead 4.0. They are of the tapered tube and float type.

The fuel sight gages, fore and aft, are to be used depending upon quantity of fuel left in the tank. There is a calibration plate on starboard side of the compartment. Directions for reading the gages are given in Part IV-D of this Handbook.

Float Controls

The float control mechanism provides for both electrical and manual operation.

The control handle for electrical operation is on the port side of the engineer's compartment. The float switch incorporates a latch which automatically shuts off the float motor when the floats reach the full "UP" or "DOWN" position. A signal light on the instrument panel shows if the floats are not down and locked when the throttles are closed.

For manual operation, a handcrank is strapped to the bulkhead below the instrument panel. For operation, insert crank in the socket at bulkhead below the panel. Two crank positions are used so that high speed operation may be used when the retracting loads are light, and the crank moved to the low speed socket as retracting loads become heavier. When the auxiliary power plant is not running, the floats should be raised or lowered by hand cranking. This procedure is necessary to avoid excessive drain on the batteries.

C. Radio and Navigator's Compartment

This compartment is aft of the pilot's compartment and is separated from it by a watertight bulkhead. The radio operator's station is on the starboard side of the central aisle. The navigator's station is on the port side.

D. Bomber's Compartment

This compartment is forward of the pilot's compartment. There is a seat for the bomber. Provision is made for bombsight and bomber's controls. A flexible gun is mounted above the bomber's position in a nose turret.

E. Living Compartment

This compartment is aft of watertight bulkhead #5.0. It contains bunks and other crew accommodations. Also, the waist and tunnel guns are located here.

F. Waist Guns

Directions for operation of the waist gun enclosure are given in Section V, Part C, of the Erection and Maintenance Manual. Before opening or closing the enclosure, reduce air speed to below 100 knots, in order to facilitate operation.

Stenciled on the aft inside end of the rotating shields of the waist gun blisters is the following -- "Notice: Gasket to be deflated at all times during flight". This is to permit equalized pressure inside the gun blister and to prevent a sharp change in pressure, such as would occur on rapid descent, which could cause failure of the plexiglas.

G. Pyrotechnics

The pyrotechnics carried in this airplane consist of the following: 2 Very's Pistols; 20 Mk. IV-1 parachute flares; 2 H.C. smoke grenades, type M-8; one Mk V, Model I smoke tank.

For information regarding the above equipment, refer to Part C-4, Section V of the Erection and Maintenance Manual.

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SECTION IV

POWER PLANT

A. Engine Description

Two Pratt and Whitney, R-1830-82, 14 cylinder, single speed supercharged engines, geared 16:9.

	BHP	RPM	ALTITUDE
Rating - Normal	1050	2450	S.L.-5400
- Take-off	1200	2700	S.L.

or

Two Pratt and Whitney, R-1830-92, 14 cylinder, single speed supercharged engines, geared 16:9.

	BHP	RPM	ALTITUDE
Rating - Normal	1050	2550	S.L.-7000
- Take-off	1200	2700	S.L.

Fuel - 100 octane, AN-F-28
91 octane, AN-F-26

(NOTE: 91 octane fuel shall be used only for training and transport operations within the continental limits of the United States - USE FULL RICH FOR TAKE-OFF AT 1200 HP - TAKE-OFFS SHOULD BE MADE AT 1100 HP WHEN OPERATING CONDITIONS PERMIT.

Oil - Grade 1100, AN Spec. AN-VV-O-446a
Recommended grade varies with operating conditions (See T.O. 24-41).

Max. Diving RPM - 3060 RPM

B. Engine Operation

Starting

The procedure for starting the engine is devided between the pilot and flight engineer, but the general procedure is as outlined here. See Check-Off List for

individual operations.

Before starting the engines, the radioman starts the auxiliary power unit. This allows the power unit to take the bulk of the starting load and prevents excessive drain on the batteries. The automatic starter switch shorts out the ammeter and fuses when the starter switch is thrown.

Turn the propellers more than two complete revolutions by hand immediately before attempting to start the engines, except when engines have been running during preceding hour.

The propellers must be set in "HIGH R.P.M." (Low Pitch) before starting.

The cowl flaps must be in the full "OPEN" position.

Starting Procedure

(a). Place mixture control in "IDLE CUT-OFF" position.
(b). Place throttle in 1000 to 1200 RPM position.
(c). Prime the engine with the priming pump.
(d). Raise fuel pressure to about 10 pounds per square inch with the wobble pump.
(e). Turn ignition switch "ON".
(f). "ENERGIZE" and "ENGAGE" starter.
(g). As soon as engine starts to fire, move the mixture control without hesitation to the "AUTOMATIC RICH" position, working the wobble pump as necessary to maintain 10 to 16 pounds per square inch fuel pressure.
(h). If engine stops, return the mixture control to "IDLE CUT-OFF" immediately.

Refer to Technical Order 29-40 "Operation of Stromberg Injection Carburetors".

Warming Up

Idle the engines at 800 RPM for not more than 30 seconds to allow the oil pressure to come up. Warm up at 1000 RPM with propeller in "HIGH RPM" (Low Pitch). Do not continue idling below 1000 RPM as this causes fouled plugs. The warm up is to continue until the oil temperature reaches the limits given in the Handbook Check-Off List.

Taxiing

In taxiing every effort should be made to restrict the engine speed to the minimum compatible with safe operation. Taxiing should not be done at very low or

ENGINE OPERATING CHART

ENGINE MODEL: R-1830-82 CARBURETOR: PD-12H1 PROPELLER: H.S.P. Constant Speed

Operating Conditions	Altitude Feet	Max. Permissible RPM	Max. Abs.Man. Press.In. Hg.	Prop. Set.	Carb. Set.	Max. Cyl. Head Temp. °C. (°F.)
Starting	S.L.	1000*	--	High RPM	Idle Cut-Off	
Take-off	S.L.	2700	48	Gov. at T.O. RPM	Auto Rich	260 (500)
Climb & Level Flight. Normal Rated Power	S.L. 5400	2450	42.5 41.0	Gov.	Auto Rich	232 (450)***
Cruising**** 70% Normal Rated Power	S.L. 4000 7000	2170	33.5 32 31	Gov.	Auto Lean	232 (450)
Landing	S.L.	2450	--	Gov.	Auto Rich	232 (450)
Stopping	S.L.	1000	--	High RPM	Idle Cut-Off	200 (392)

"Oil-In" Temperatures - 25°C. Minimum for T.O.: Desired for other conditions 54° - 95°C. (See T.O. No. 24-41)
Oil Pressure: Maximum - 105 lbs./sq.in. Desired: 85 - 100 lbs./sq.in.
Fuel Pressure: 14 to 16 lbs./sq.in. Idling Minimum: 15 lbs./sq.in.

* Maximum Recommended RPM
** See T.O. 9-40 and 16-41
*** 260°C. is the limit for one hour operation
**** See P. 36A for other cruising conditions

FIGURE 7

ENGINE OPERATING CHART

ENGINE MODEL: R-1830-92 CARBURETOR: PD-12H1 PROPELLER: H.S.P.CONSTANT SPEED

Operating Conditions	Altitude Feet	Max. Permissible RPM	Max. Abs.Man. Press.In. Hg.	Prop Prop. Set.	Carb. Set.	Max. Cyl. Head Temp. °C. (°F.)
Starting	S. L.	1000*	--	High RPM	Idle Cut-Off	
Take-off	S. L.	2700	48	Gov. at T.O. RPM	Auto. Rich	260 (500)
Climb & Level Flight Normal Rated Power	S. L. 7000	2550	42.0 39.5	Gov.	Auto. Rich	232 (450)***
Cruising**** 70% Normal Rated Power	S. L. 4000 7000	2170	33.5 32 31	Gov.	Auto. Lean	232 (450)
Landing	S. L.	2550	--	Gov.	Auto Rich	232 (450)
Stopping	S. L.	1000	--	High RPM	Idle Cut-Off	200 (392)

"Oil-In" Temperatures - 25°C. Minimum for T.O.: Desired for other conditions 54° - 95°C. (See T.O. No. 24-41)
Oil Pressure: Maximum - 105 lbs./sq.in. Desired: 85 - 100 Lbs./sq. in.
Fuel Pressure: 14 to 16 lbs./sq.in. Idling Minimum: 15 Lbs./sq.in.

* Maximum Recommended RPM
** See T.O. 9-40 and 16-41
*** 260°C. is the limit for one hour operation
**** See P. 36A for other cruising conditions

FIGURE 7

very high RPM. No restriction can be placed on taxiing RPM, but it should be noted that a large part of ignition troubles are due to fouling of plugs from idling at low speeds or overheating of the installation due to high taxiing speeds. The cowl flaps should be wide "OPEN" for all taxiing operations.

Take-Off

For take-off the mixture control should be set in "AUTOMATIC RICH" position. The propeller must be set in low pitch ("HIGH RPM") for 2700 RPM. The maximum manifold pressure should be 48 in. Hg. It corresponds to 1200 BHP at 2700 RPM. The maximum allowable RPM is 2700. The maximum cylinder head temperature (for 5 minutes) is 260°C.

Climb and High Speed Level Flight

For maximum performance (rated) the propeller should be governed to 2550 RPM (-92 engines) or 2450 RPM (-82 engines), the mixture control set at "AUTOMATIC RICH" and the manifold pressure as given below:

Altitude	Manifold Pressure (-82)	(-92)
S.L.	42.5	42.0
3000	41.5	41.0
6000	F.T.	40.0
7000	F.T.	39.5

After a long climb or going to a higher power in cold weather, momentarily reduce the propeller pitch (increase RPM) to permit hot engine oil to clear out the mechanism).

Cruising

While cruising may be conducted at any power and RPM below rated power and RPM; to obtain low fuel consumption all cruising operations should be conducted in a range not to exceed 70 percent of normal rated power.

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The engines should be operated in AUTO LEAN at 70% power and below except when conditions are such that a cylinder head temperature of 232°C is exceeded with cowl flaps open. In such cases the mixture should be enrichened.

Manual leaning beyond AUTO LEAN to the point of engine roughness is permissible at cruising powers for minimum fuel consumption.

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Landing

In landing, the propeller governor should be set at "HIGH RPM" (Low Pitch). The mixture control is to be placed in "AUTOMATIC RICH" and the cowl flaps "OPEN".

During long glides at part or closed throttle, with low air temperatures, occasional operation of the propeller and throttle controls is recommended in order to prevent congealing of the oil in the propeller cylinder. The pitch change introduces hot oil into the cylinder.

The carburetor air control is normally to be kept to the stop in "DIRECT" position. If wing icing conditions, snow, sleet or rain, are encountered, adjust the control according to Section IV, Part F.

Stopping the Engine

To stop the engines: Idle at 1000 RPM. The cowl flaps are to be "OPEN". The cylinders should be cooled below 200°C. (392°F.) Move the mixture control to the "IDLE CUT-OFF" position. When the mixture control is in this position, the motor stops. After the engine stops, turn the individual ignition switches to "OFF" position. Pull the master switches to "OFF" when both engines have stopped. The cutting of the switches to stop the engines is not recommended, although sometimes this is necessary in coming up to a buoy or a ramp in order to make a better contact.

The fuel cock will not be shut "OFF" except in an emergency. This will keep the fuel lines from the injector to the discharge nozzle filled with fuel and avoid undue cranking or delayed starting for subsequent operation. See Technical Order 39-40 "Operation of Stromberg Injection Carburetors".

Mixture Control

The mixture control shall be set in the "AUTOMATIC RICH" position for all operations except cruising. The "FULL RICH" position is used only in an emergency upon a failure of the automatic control. The "AUTOMATIC LEAN" position is used for cruising only.

The mixture control is to be left in the "IDLE CUT-OFF" position at all times when the engine is not in operation.

Cylinder Temperatures

Cylinder temperature operation shall be within the following limits. The maximum allowable head temperatures for take-off (five minutes) is 260° C. (500° F.).

For normal rated power, high speed and climb (1 hour) the maximum is 260° C. For cruising the recommended maximum is 232° C. The maximum Barrel temperature of all conditions is 168° C.

Cowl Flaps Operation

The cowl flaps are to be fully opened for starting and for all ground running and taxiing. During ground running and taxiing, the head temperature should be kept below 260° C. Just before take-off allow the engine to cool below 232° C. so temperature won't exceed allowable limits during the take-off. For the take-off or landing the cowl flaps should be open. For a steep climb the cowl flaps should be 1/2 open or as required to maintain proper temperature. In other conditions, adjust for proper cooling. Do not close to accelerate the warm-up.

The cowl flap controls are located on the bulkhead below the flight engineer's panel. To operate the control turn the crank in the direction indicated by the arrow.

Vibration

Vibration analyses in flight show that the peaks of certain of the vibration curves of the engine and the Hamilton-Standard Propeller, 23E50 Hub with 6153A-12 blades, fall in the engine speed range between 2450 and 2650 RPM. It is necessary to restrict the engine operation to avoid or pass through quickly the range between 2450 and 2650 RPM. Take-offs are to be made as close to 2700 RPM as practicable.

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C. **Check-Off List**

Starting Engines

Pilot	Flight Engineer
	1. Turn engines over by hand.
2. Instruct radio operator to start auxiliary power unit and connect interphone visual system	
3. Set propeller in "Low Pitch". (High RPM)	
4. Set interphone control switch in position #4.	
5. Signal flight engineer to prepare to start port or starboard engine.	
	6. Set mixture control in "IDLE CUT-OFF" position
	7. Cowl flaps - set fully open.
	8. Fuel Valves - open to the correct positions.
	9. Fire Extinguisher - set for engine to be started
	10. Check for current at starters.
11. Throttles set 1000 to 1200 RPM position.	
	12. Carburetor Air Controls - set in "DIRECT" position
	13. Prime with primer pump 3 to 5 strokes.
	14. Fuel Pressure - 10 to 14 lbs. per sq.in. with hand wobble pump.
	15. Signal pilot for "contact"
16. Close individual engine ignition switch on signal from engineer.	
	17. Energize starter.
	18. Engage starter.
	19. Mixture Controls - Shift to "AUTOMATIC RICH" with out hesitation as soon as engine starts firing. If engine stops, return to "IDLE CUT-OFF" immediately.
	20. Idle engine at 800 RPM until oil pressure registers (within 30 second) or shut off.

Warm Up

Pilot	Flight Engineer
	1. Cowl flaps - full open.
2. Warm up engine at 1000 RPM if oil pressure up. Propeller in low pitch.	
	3. Check oil pressure (at 1000 RPM). Should be about 40 to 100 lbs. depending upon the temp.
	4. After oil is warm (60° or above) check oil pressure at 1500 RPM 65 lbs. min., to 100 lbs. max.
5. Propellers - Check propeller operation.	
	6. Check carburetor air control to "DIRECT position.
	7. Check "Floats Down".
8. Taxi into water.	
	9. Second mechanic secure ladder and close hatches.

Take-Off

1. Check elevator, rudder & aileron tab settings	
	2. Check "Floats Down".
	3. Check oil pressure and oil temperature normal.
	4. Mixture control - set at "AUTOMATIC RICH"
	5. Carburetor Air Control - set for "DIRECT" air.
	6. Cowl flaps - full "OPEN" so that cylinder temperature before take-off will not exceed 232° C.
	7. Report to pilot when ready.
	8. Cowl flaps - Adjust to maintain cylinder temperatures not exceeding 260°C. in climb for 1 hour, 232°C for cruising
9. Propellers set for 2700 RPM	
10. Reduce RPM immediately after take-off to 2550 2450 for -82 engines). Maintain 42.0" Hg. or less manifold pressure.	

Take-Off

Pilot	Flight Engineer
11. Signal for "floats up" as soon as practible.	
	12. Raise floats.
	13. Turn out lights.

Before Landing

1. Signal crew to prepare for landing.	
2. Signal "FLOATS DOWN".	
	3. lower floats.
4. Propellers - Set for take-off position ("HIGH RPM").	
5. Signal engineer to shift to "AUTOMATIC RICH".	
	6. Mixture control - Set for "AUTOMATIC RICH".
	7. Carburetor Air Control "DIRECT".
	8. Second mechanic stand by sea anchor after landing

Stopping Engines

	1. Cowl flaps - Open. Cylinder temperature not to exceed 200°C. before stopping.
2. Throttles open 1000 RPM (cut switches if necessary when coming up to buoy or beach). Idle at 800 RPM.	
3. Leave propeller control in low pitch ("HIGH RPM")	
4. Signal engineer to stop engines.	
	5. Put mixture control in "IDLE CUT-OFF" position.
6. Cut switches after engines stop.	
7. Signal "Secure" after plane is beached or secure to buoy.	
	8. Radioman secure lights and interphones.
9. Put on rudder and yoke locks.	
10. Install battens on control surfaces and lock rudder in neutral position.	

D. Fuel System

For fuel system diagram refer to Figure 8 of this Handbook.

The fuel is carried in two fuel tanks integrally built in the wing center section. Each tank has a capacity for 875 gallons of fuel.

The sight gages are in the engineer's compartment at the fore and aft bulkheads overhead. For over 100 gallons of fuel, read the fore gage and for under 100 gallons, read the aft gage. Rear the applicable gage and apply the apparent reading to the calibration and instruction plate on the starboard side. The plate is calibrated for different attitudes of the airplane. Read across to the correct column which gives the actual fuel remaining in the tank. Calibrations are given for the following ship conditions: Water Borne; Beaching Gear, Cruising at 105 knots and 140 knots. An inclinometer on the starboard wall allows the engineer to check the ship attitude.

Fuel may be supplied to either or both engines from either or both tanks by means of two selector valves located on the engineer's panel. The port valve supplies fuel to the port engine and the starboard valve supplies fuel to the starboard engine. The auxiliary power plant fuel is supplied through a control valve on the engineer's panel. A cross feed valve on the panel allows for fuel to be supplied to both main engines from the engine-driven fuel pump of either engine.

The fuel dump valve controls, located directly over the engineer's head, are pulled down to dump fuel. The valve reseats itself when the control is released so that any desired amount of fuel may be dumped from either tank. At the time of publication of this Handbook, fuel dumping from all Model PBY airplanes is prohibited.

The fuel pressure desired at the carburetor is 15 lbs/sq.in., or 16 lbs. at the engineer's gage. Minimum 15 lbs. Maximum 17 lbs.

E. Oil System

There is a complete oil system for each engine (Figure 9 for diagram). The removable oil tank built as part of the monocoque nacelle has a capacity of 65 gal.-

The oil system includes: An automatic oil temperature regulator and cooler with a pressure by-pass control; a liquidometer type quantity gage; a sounding rod; and a pressure and temperature gage.

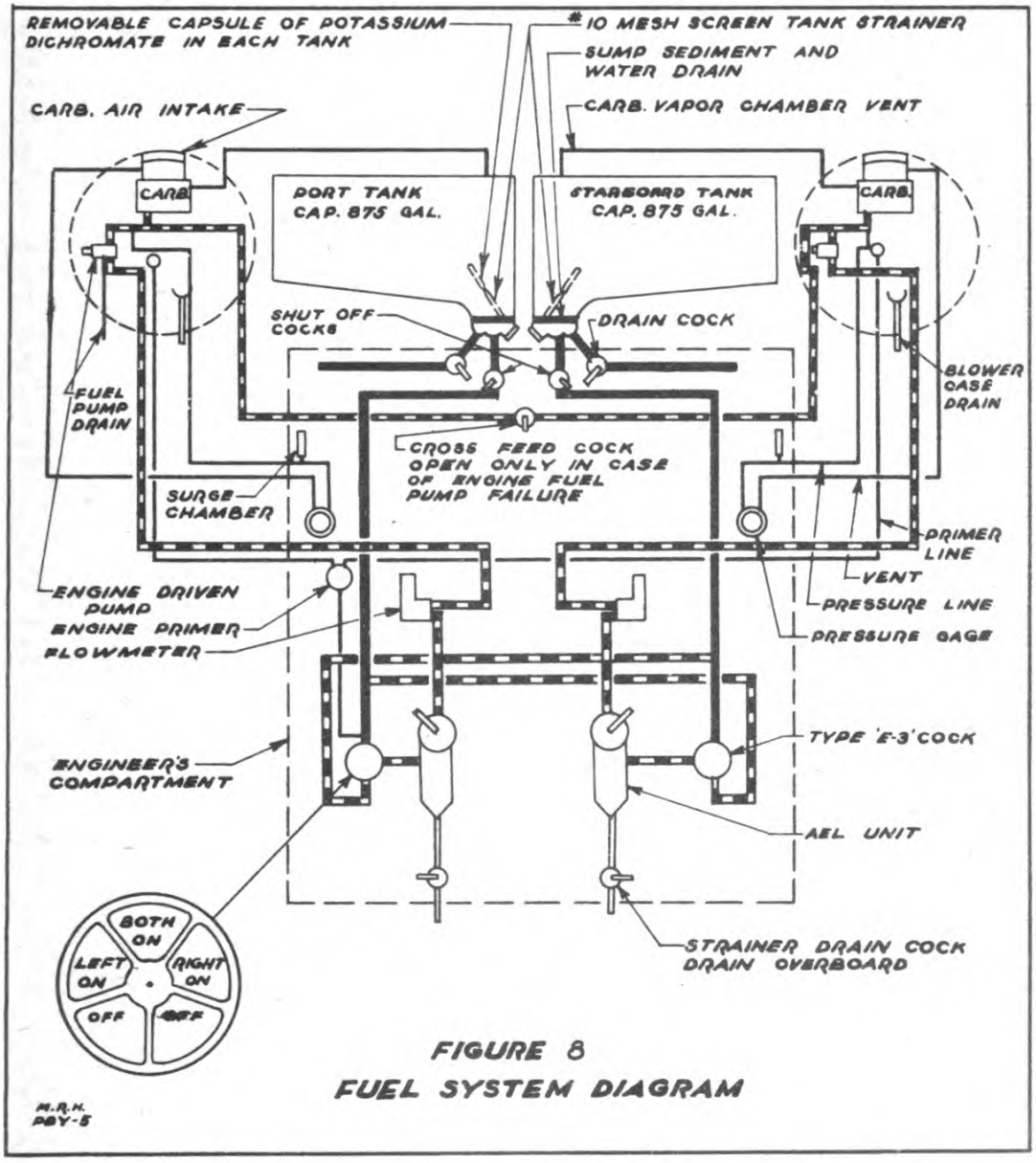

FIGURE 8
FUEL SYSTEM DIAGRAM

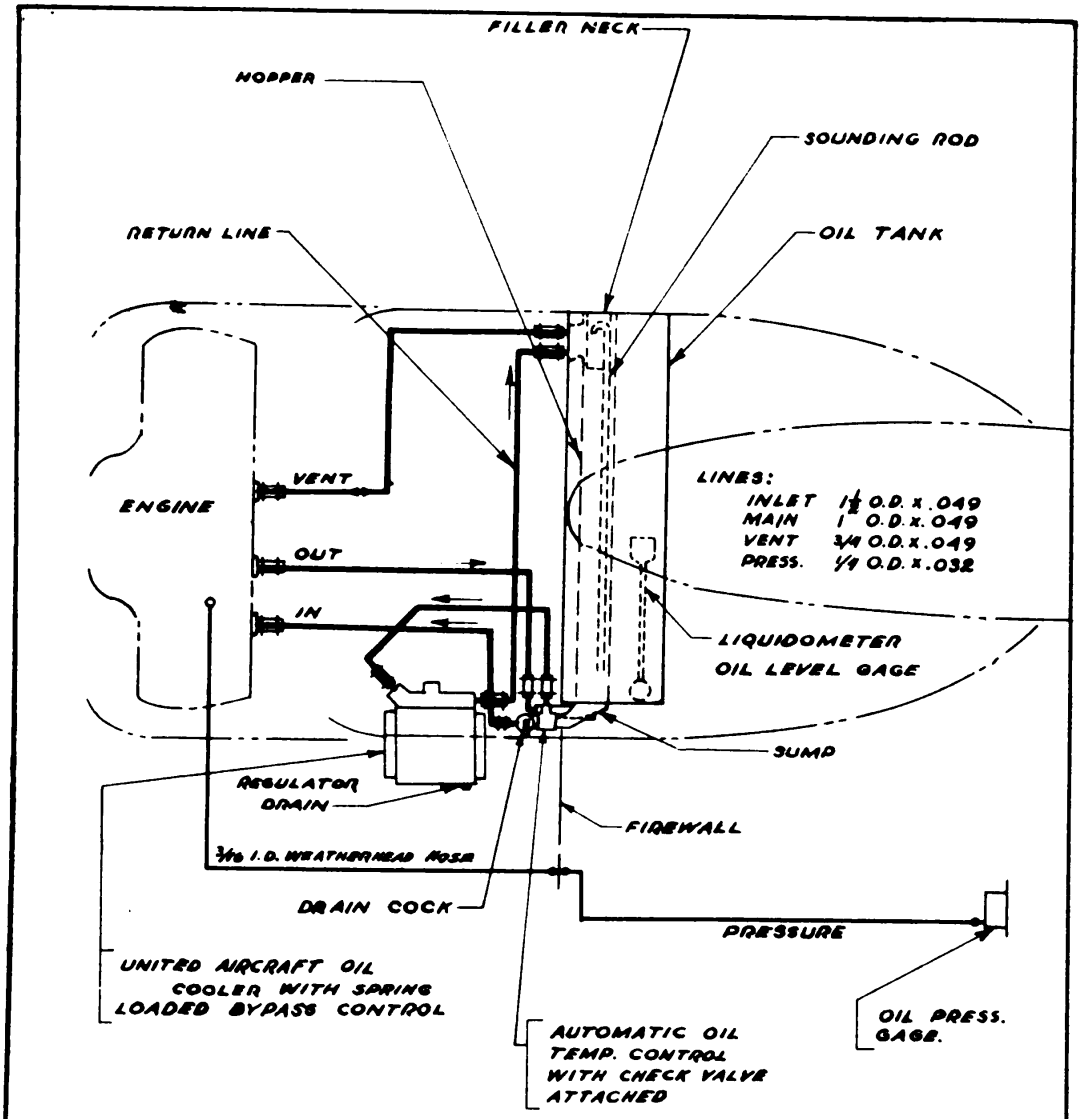

FIGURE 9
OIL SYSTEM DIAGRAM

The oil temperature regulation is completely automatic. The temperature control unit by-passes the oil from a cold engine directly back to the bottom of the oil tank. As the oil "IN" temperature rises an increasing proportion flows through the oil cooler and then to the top of the oil tank. The core of the oil cooler is protected from excessive pressure by a spring-loaded by-pass valve which, when open, directs the oil through the jacket instead of the core. Each tank contains a quick warm-up compartment.

The normal oil pressure at 2000 RPM is 80 - 100# per sq.in. Minimum allowable pressure is 80#/sq.in.

The position of the cowl flaps will indirectly influence the oil temperature by controlling the engine cooling.

F. Carburetor Air Control

The carburetors used on this airplane are of the non-icing type. A protected air source is provided inside the engine cowling, which is to be used only under icing-conditions and heavy rain, snow or sleet. Since no carburetor air temperature indicator is provided, a loss in manifold pressure might indicate icing at the carburetor screen.

The two extreme positions of the carburetor air control at the engineer's station are marked "ALTERNATE" and "DIRECT". The controls are adjustable for intermediate positions. In the full "ALTERNATE" position, air is taken from the opening inside the engine cowling. In the full "DIRECT" position, this opening is closed, and air enters the carburetor scoop from the outside air duct at the nose of the cowling.

The carburetor air control shall be set to full "ALTERNATE" if ice forms at the carburetor screen. This condition is indicated by a loss of manifold pressure. Reduce power to avoid detonation. Watch for any rise in cylinder temperatures which would indicate detonation and overheating. When the ice has been cleared, the control shall be returned to an intermediate position between "ALTERNATE" and "DIRECT" to prevent the further formation of ice on the screen. As soon as possible, or when icing conditions are no longer encountered, return the control to the full "DIRECT" position, to protect the engine against excessively high carburetor air temperatures. High carburetor air temperatures may be accompanied by detonation which must be avoided at all times.

G. Propellers

The PBY-5 airplanes are equipped with either Hamilton-Standard Hydromatic or Curtiss Electric, full-feathering propellers. At the date of revision of this Handbook, the types of propellers are tentatively assigned to the airplanes as given below.

Hamilton Hydromatic

Airplanes with serial numbers 2289 to 2346 inclusive, 2356 to 2421 inclusive, and 2428 and following airplanes are equipped with Hamilton-Standard Hydromatic full-feathering propellers. They are three-bladed, 12-foot diameter, aluminum propellers.

The governor is a Hamilton Constant speed model 4-L-11. It is controlled by the pilot. See Figure 4 for location overhead beside the pilot's throttles.

The feathering control switch is located forward of the throttle quadrant on the pilot's ceiling.

It is desirable to leave the propellers in low pitch as the starting load is then minimized.

Curtiss-Electric

Airplanes with serial numbers 2347 to 2355 inclusive, and 2422 to 2427 inclusive, are equipped with Curtiss Electric, full-feathering propellers. They are three-bladed 12-foot diameter, hollow steel propellers.

The governor is a Curtiss Constant Speed Model 100,006. There is no automatic synchronization. The switch selects either the governor or manual control.

The feathering switches, and manual and automatic switches are on a separate panel on the control yoke between the pilots.

H. Auxiliary Power Plant Unit

The auxiliary power plant is located aft of bulkhead 4 on the port side of the airplane.

The unit is a 4 horsepower, Eclipse Model, single cylinder, Navy type NEP-2

It is controlled from the radio operator's station by switches in the main distribution panel.

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SECTION VI

OPERATION CHARTS, DATA AND CURVES

A. Operating Limits Chart

This chart can be used to set operating conditions or to determine engine power at any given operating condition within the recommended operating limits of the engine. The horizontal dot-dash line indicates the limit for AUTO LEAN operation. Use AUTO RICH above this line. Part throttle conditions are those to the left of the oblique heavy dashed lines; full throttle conditions are those to the right of these lines.

High Power - AUTO RICH (Part Throttle)

1. When high power climb is desired, operate along one of the constant manifold pressure-constant RPM lines (sloping lines labeled with RPM and manifold pressure). For constant rated power climb use 42" Hg. at S.L. and decrease 1" Hg. per 3000 feet above S.L. (42.5" Hg for -82 engines).

2. Select level flight conditions from a point on one of the designated lines, or, if an intermediate condition is desired, any manifold pressure-RPM relationship shown in the full throttle portion of the chart can be used for part throttle operations.

Cruising Power - AUTO LEAN (Part Throttle)

1. For power conditions below the dot-dash line, the recommended manifold pressures are independent of RPM.

2. Rule of thumb: Use 32.5" at S.L. and subtract 1" per 3000 ft.

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To Determine Horsepower - Any Power Condition

1. Spot the RPM-manifold pressure condition in the full throttle portion of the curve.

2. Draw a line through the point parallel to the constant manifold pressure-constant RPM lines shown (sloping lines labeled with manifold pressure and RPM).

3. Read HP at intersection of this line with observed pressure altitude.

4. To correct this power for temperature: Add 1% power for each 6°C. CAT is below Standard (shown on chart). Subtract 1% power for each 6°C. CAT is above standard (shown on chart).

Pressure Altitude.

1. Determine the amount the barometric pressure (altimeter window reading) is above or below 29.92" Hg.

2. Add 100 feet to indicated altitude for each 0.1" Hg. below 29.92; subtract 100 feet for each 0.1" Hg. above 29.92.

3. Alternate method - set one of the altimeters to 29.92 and read directly.

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B. Cruising Control Chart

True airspeed vs. brake horsepower in level flight at any pressure altitude and atmospheric temperature is shown by the accompanying chart, Figure 11, for any patrol loading without bombs. If bombs are carried the drag is increased and the chart is not applicable.

Due to the wide variation of weight during any prolonged flight, with the PBY-5 airplane, a chart for a single weight will not show accurately the variation of airspeed with power. Therefore, two weights are shown which will bracket the weight variation for any flight. Data for intermediate weights may be obtained by interpolation.

An example of the use of the chart is given below:

Assume pressure altitude	= 10,000 ft.
Assume outside air temperature	= 5° C.
Assume true indicated airspeed	= 130 MPH

(Note: It is assumed that an airspeed indicator calibration curve is available which may be plotted as true indicated airspeed in MPH vs. airspeed indicator reading in knots).

Assume weight at a particular time during flight	= 24,500 lbs.
True airspeed (from chart)	= 154 MPH
BHP/Eng. @ 29,000 lbs. (from chart)	= 600
BHP/Eng. @ 20,000 lbs. (from chart)	= 520
By interpolation BHP/Eng. @ 24,500#	= 560
Percent normal power = 560/1050	= 53 %

(Note: Normal power = 1050 BHP/Engine)

C. Fuel Consumption Curves

Figure 12 shows the Fuel Consumption Curves as plotted from the best available engine test data submitted by the engine manufacturer.

The Fuel Consumption Curves, Figure 12, show the fuel consumption in gallons per hour per engine as a function of RPM for three altitudes. Data for other altitudes may be obtained by interpolation.

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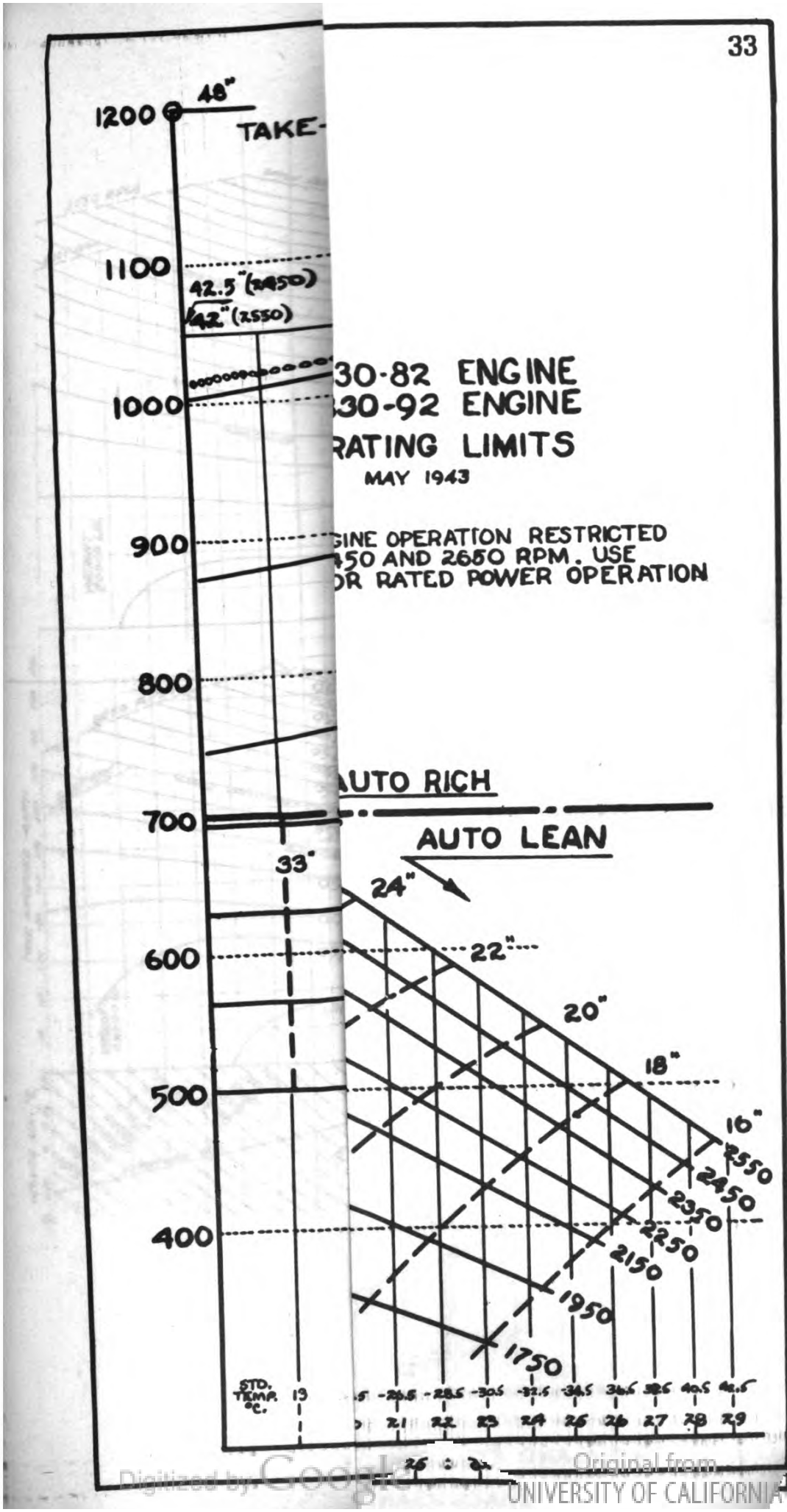

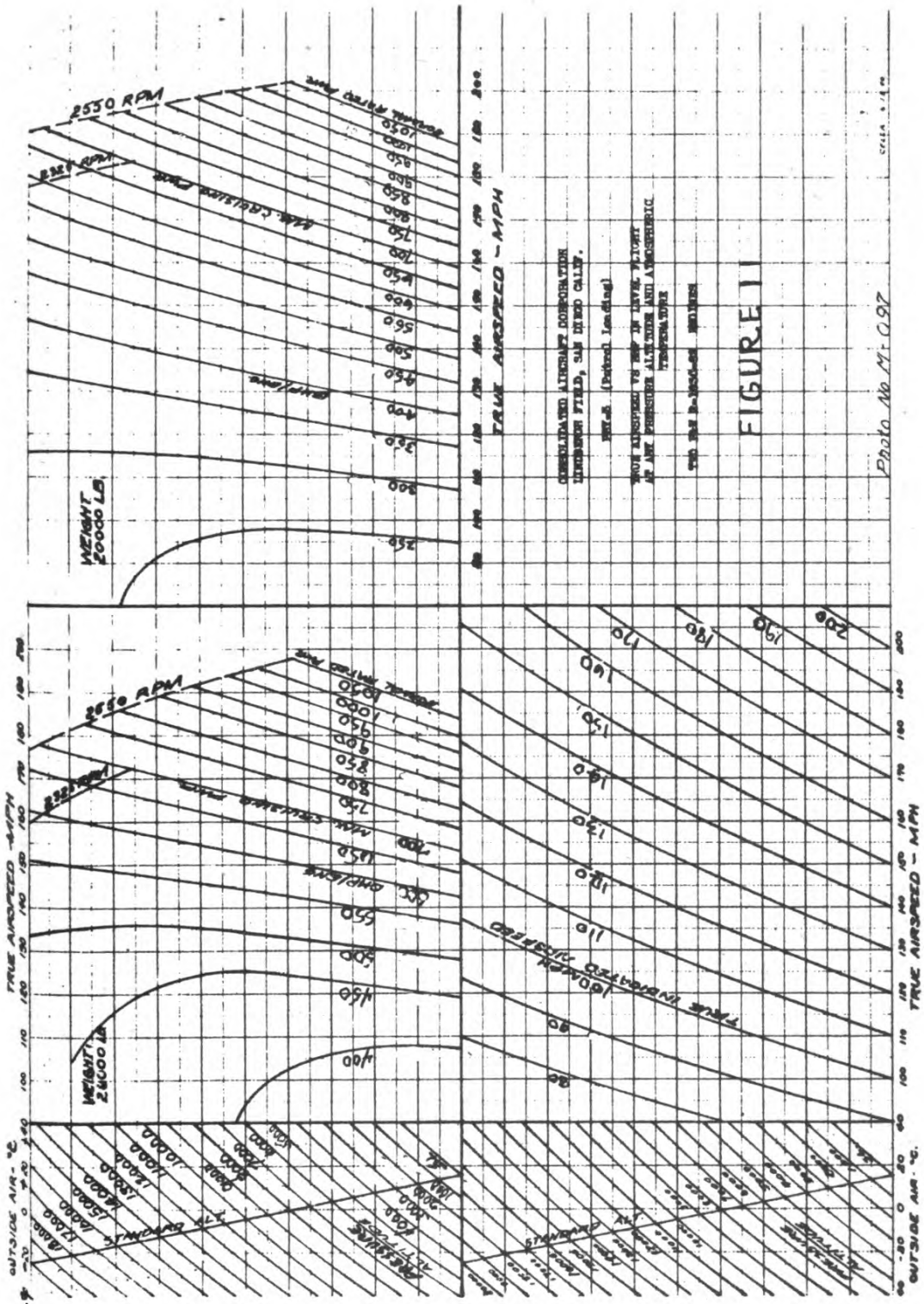

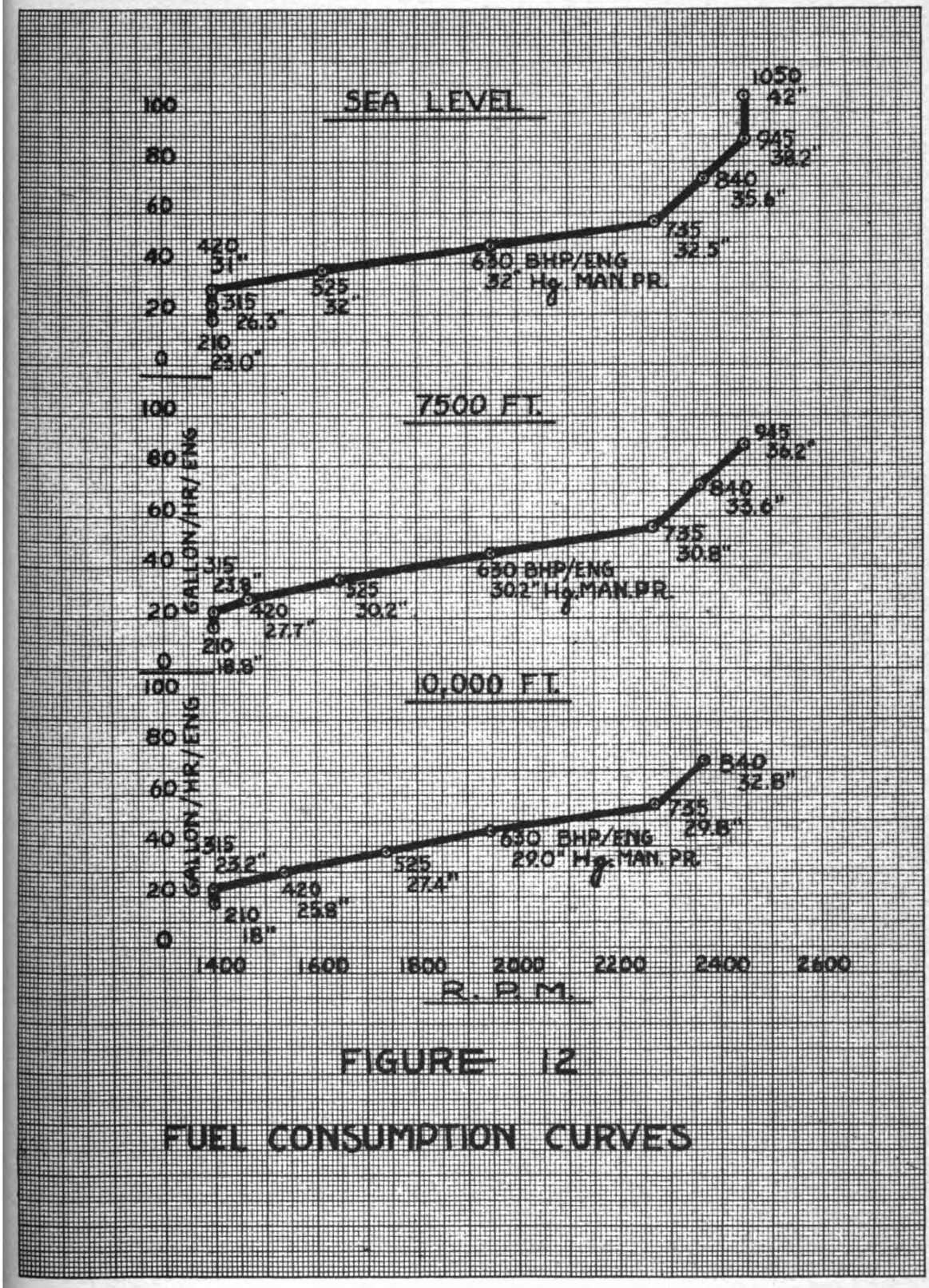

FIGURE- 12

FUEL CONSUMPTION CURVES

SECTION VI

NORMAL INSTRUMENT READINGS

Pressure Altitude Feet	70% Power 140 BMEP - Auto Lean		60% Power 140 BMEP - Auto Lean		50% Power 140 BMEP - Auto Lean	
	RPM	Man. Pres. "Hg. (Abs)	RPM	Man. Pres. "Hg. (Abs)	RPM	Man. Pres. "Hg. (Abs)
1,000	2170	33.5	1950	33.5	1610	33.0
4,000	2170	32.0	1950	32.0	1610	32.0
7,000	2170	31.0	1950	31.0	1650	F.T.*
10,000	2170	30.5	2050**	F.T.*	**	
13,000	2275**	F.T.*	**		**	

* Full throttle altitude varies with operating conditions.
** Increase RPM to maintain power (140 BMEP no longer obtainable)

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Figure 13

CRUISING CHART

SECTION VII

FLYING CHARACTERISTICS

A. Weight Distribution and Balance

The following table, Figure 13, summarizes the locations of horizontal C.G.'s (% M.A.C.) as determined from the Consolidated Aircraft Actual Weight and Balance Report, ZW-28-031 of August 26, 1940. This report was prepared for the PBY-5 as built for the U. S. Navy.

In these loading conditions, all the Disposable Weight Empty Items are assumed to be in their proper positions as given in Report ZW-28-031. The Special Load Items are not included. If any of the Special Load Items are carried, they should be located in the vicinity of the tool and gear locker or further forward in order to maintain correct longitudinal balance.

B. Take-Off

For the Pilot's and Engineer's Check-Off-list, refer to Parts 1, 2, 3 and 4 of Section IV-C.

The curves on Figure 14 give the Take-Off time for the airplane under varying conditions of loading at altitudes from Sea Level to 8,000 feet.

C. Stalling

The curves on Figure 15 give the stalling speed in MPH., for the airplane under varying conditions of loading at altitudes from Sea Level to 8,000 ft.

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	Weight Lbs.	Horizontal C.G. (% M.A.C.)
Weight Empty	15,384	
Gross Weight - Functional Crew		
785 Gal. Patrol	23,872.4	28.1
1570 Gal. Patrol	28.957.4	29.3
500 Gal. Bomber (2) 1000# Bombs	24,189.8	27.3
500 Gal. Bomber (4) 1000# Bombs	26,189.8	27.4
500 Gal. Bomber (12) 100# Class Bombs	23,711.4	27.9
1000 Gal. Bomber (2) 1000# Bombs	27,377.3	28.3
500 Gal. Torpedo(2) Mk.XIII Torpedoes	26,227.6	27.5
500 Gal. Bomber less Bombs, Amm. & Fuel	18,692.2	22.9
785 Gal. Patrol - with Smoke Tank Inst.	24,914.4	28.1
Gross Weight - Battle Crew		
785 Gal. Patrol	23,872.4	30.4
1570 Gal. Patrol	28,957.4	31.2
500 Gal. Bomber (2) 1000# Bombs	24,189.8	29.6
500 Gal. Bomber (4) 1000# Bombs	26,189.8	29.5
500 Gal. Bomber (12) 100# Class Bombs	23,711.4	30.3
1000 Gal. Bomber (2) 1000# Bombs	27,377.3	30.3
500 Gal. Torpedo(2) Mk.XIII Torpedoes	26,227.6	29.7
500 Gal. Bomber less Bombs, Amm. & Fuel	18,692.2	25.9
785 Gal. Patrol - with Smoke Tank Inst.	24,914.4	30.3
Most Forward Flying C.G.		22.0
Most Aft Flying C.G.		31.6

Crew Functional Stations

Pilot
Co-Pilot
Navigator
Radio Operator
Flight Engineer
Bunk Station 4 - 5
Bunk Station 5 - 6

Crew Battle Stations

Bomber
Pilot
Radio Operator
Flight Engineer
Waist Gunners (2)
Tunnel Gunner

FIGURE 13

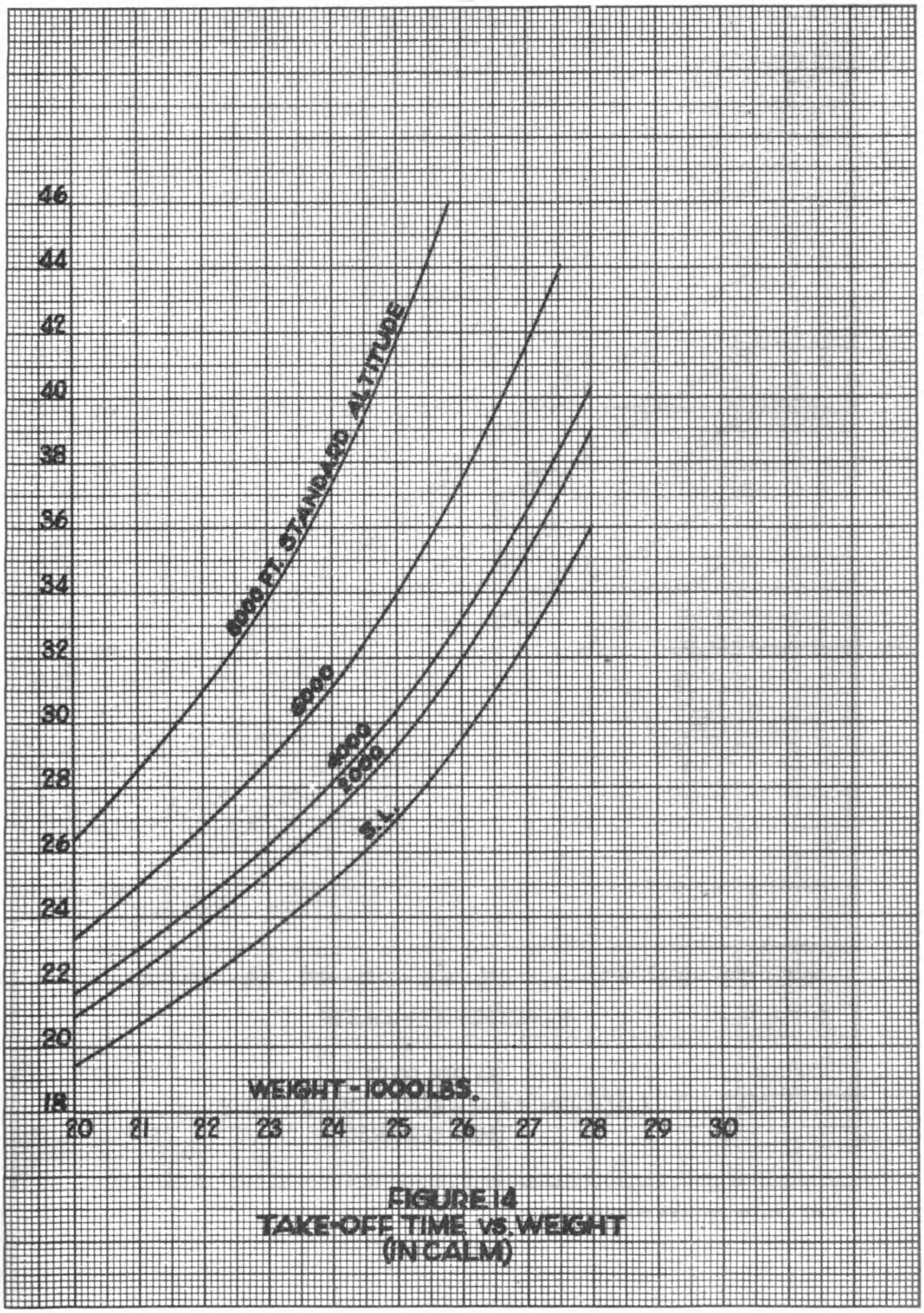

FIGURE 14
TAKE-OFF TIME vs. WEIGHT
(IN CALM)

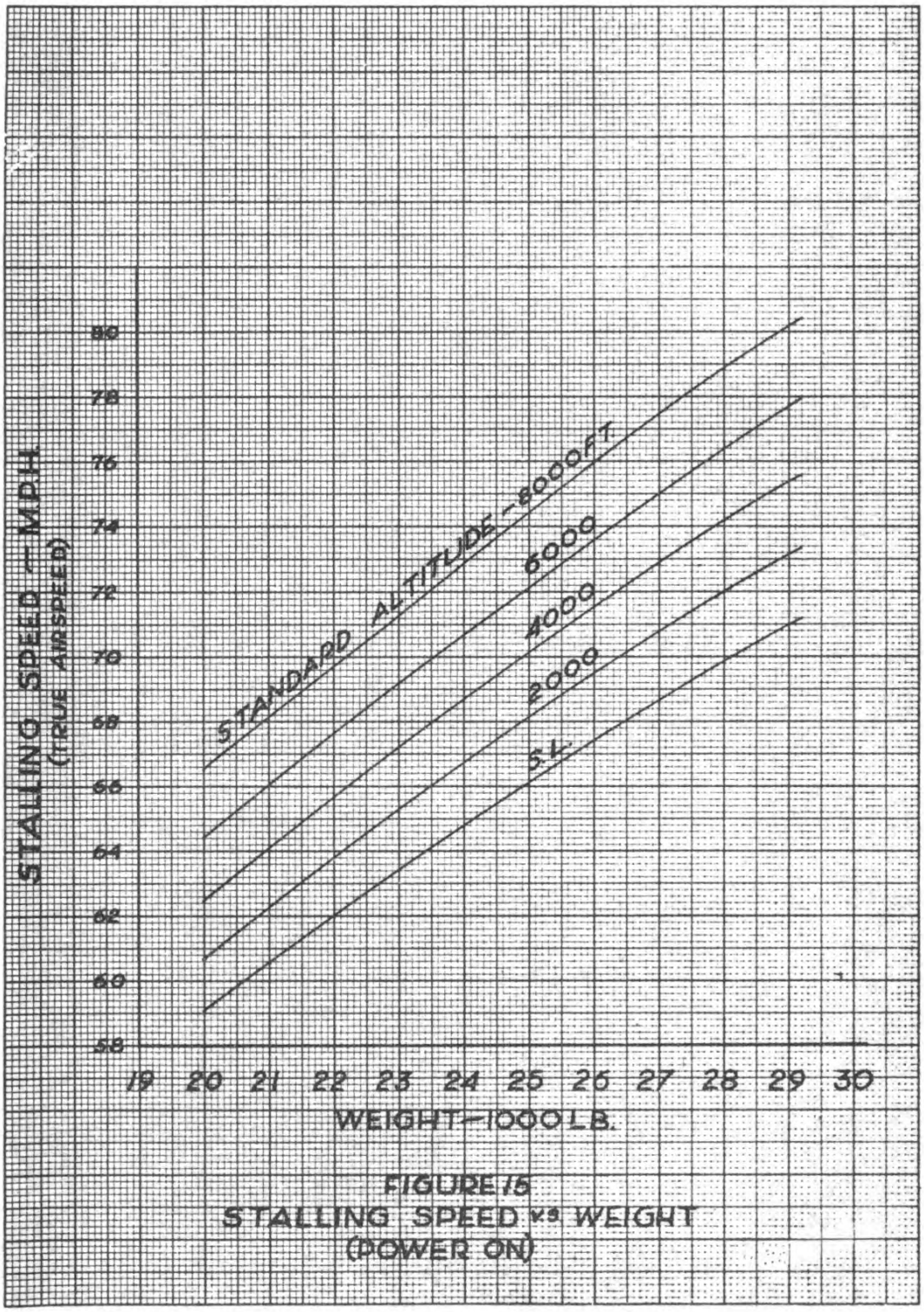

FIGURE 15
STALLING SPEED vs WEIGHT
(POWER ON)

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